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Forest owners' views on storing carbon in their forests

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Forest owners' views on storing carbon in their forests

Abstract

Given the high percentage of private forest ownership in Finland, family forest owners have an important role in mitigating climate change. The study aims to explore Finnish family forest owners' perceptions on climate change and their opinions on increasing carbon storage in their forests through new kinds of management activities and policy instruments. The data consists of thematic face-to-face interviews among Helsinki metropolitan area forest owners (n=15). These city-dwellers were expected to be more aware of and more interested in climate change mitigation than forest owners at large. Forests as carbon fluxes appear to be a familiar concept to most of the forest owners, but carbon storage in their own forests was a new idea. Four types concerning forest owners' view on storing carbon in their forests could be identified. The Pioneer utilizes forestland versatily and has already adopted practices to mitigate climate change. The Potential is concerned about climate change, but this is not seen in forest practices applied. The Resistant is generally aware of climate change but sees a fundamental contradiction between carbon storing and wood production. The Indifferent Owner believes that climate change is taking place but does not acknowledge a relation between climate change and the owner's forests.

Keywords: attitudes; carbon storage; climate change; family ownership; forest management

Introduction

About one third of anthropogenic CO₂ emissions since the 18th century have resulted from land use. Simultaneously, and increasingly over time, forests have become a net carbon sink so that the total land-based carbon sink has risen to the level of 6 Gt CO₂ per year (IPCC 2013). As a result, the forests offset nearly one fifth of fossil emissions and there is an increasing interest in trying to increase the carbon sink function of forests.

As a member of the Annex I countries in the United Nations Framework Convention on Climate Change (UNFCCC), Finland monitors and reports its amount of forest carbon storage annually, following the reporting guidelines developed under the International Panel on Climate Change (IPCC) (UNFCCC 2014). In the UN Climate Change Conference in Durban, 2011, it was agreed that a reference level of the forest carbon sink would be applied. The current reference level for the carbon sink in Finland is 19 mill. tons CO₂ annually. In comparison, the annual sink of Finland's LULUCF sector (land use, land use-change and forestry) has been 22–50 mill. tons CO₂ during the last 35 years (Statistics Finland 2016). While the difference between the reference level and the annual sink has been considerable, the tightening climate policy (Effort sharing 2016) is expected to ramp up the pressure to increase the reference level considerably and to eliminate the positive gap between the reference level and the annual sink. Hence, enhancing the forest carbon sink may become an important element of Finnish forest and climate policy.

One of the most effective means of increasing carbon sequestration and mitigating climate change is to increase carbon storage in forests, which would mean refraining from timber harvesting completely (van Kooten et al. 1995; Ekholm 2016), postponing thinnings or final harvests (Pohjola and Valsta 2007), or enhancing forest

growth by fertilizing the forests (Sathre et al. 2010) in some forest areas. The selection of tree species, variation in replanting and growing density, and the use of selective cutting methods (Assmuth and Tahvonen 2018) can also increase carbon storage in the forest. The adoption of selective cutting methods or continuous cover forestry has been relaxed by a recent change in the Finnish legislation.

Given the high percentage of private forest ownership in Finland, family forest owners have an important role in mitigating climate change. These ownerships are, on average, rather small and held by aging owners. The amount of absentee ownership is increasing along with urbanization, and the objectives for owning forest land are diversifying (Karppinen et al. 2015). The production of public goods on private lands is largely an unstudied field in the Finnish context. This is partly due to the practice of Everyman's Rights, which gives certain use rights to anyone, regardless of who owns the forest. Based on this tradition, forests can be used for activities such as hiking, bird-watching, mushroom and berry picking, and even for camping without making a fire. Some studies have examined the voluntary safeguarding of biodiversity in family forests via the METSO program (e.g. Horne 2006; Mäntymaa et al. 2009), which is a specially tailored cost-share program enhancing biodiversity (see Vanhanen et al. 2012).

Previous studies on forest owners' willingness to enhance carbon sequestration in their forests have identified four types of affecting factors: general economic factors such as the underdevelopment of carbon markets and the low price of carbon, owner and holding characteristics, the objectives of forest ownership, and factors related to policy instruments (Table 1).

(Table 1 around here)

The low price of carbon, low profitability in the carbon trade and poorly developed markets have not encouraged participation in carbon storage in the owners' forests (Table 1). Subsidies have been regarded as having a positive effect on the willingness to store carbon, but many issues related to program contracts have had negative effects, such as a contract with a long duration, use restrictions, special management requirements and penalties for quitting the program. On the other hand, the preservation of property rights has had a positive effect.

The effects of the owner and holding characteristics have often been ambiguous in the light of the previous literature. However, a long length of land tenure, absentee ownership, increasing household income and a high level of education along with a large forest acreage seem to encourage participation in carbon programs. Knowledge and positive attitudes towards carbon sequestration and the role of forests have enhanced participation. Non-timber, recreational and nature-oriented objectives for forest ownership have also had a positive effect on the willingness to take part in carbon storage (Table 1). On the other hand, bequest motives or the intention to sell forest property have not encouraged participation in carbon storage in the forests.

In the future, there will be pressures to increasingly store carbon in forests. Therefore, this study aims to describe Finnish family forest owners' perceptions on climate change and their opinions on increasing carbon storage in their forests through new kinds of management activities as well as policy programs and instruments. A typology based on forest owners' views on storing carbon in their forests will be created. It helps policy-makers and extension and service providers to adjust policy instruments and services to match the needs of various types of forest owners. Although forest owners typologies are far from being rare in forest owner literature (see Ficko et al. 2017), very few typologies concern climate change views (Laakkonen et al. 2018).

Material and Methods

The data were collected by conducting face-to-face interviews (n=15) among members of Helsinki metropolitan area forest owners' association, PKMO, in 2015. These city-dwellers were expected to be more aware of and more interested in climate change mitigation than forest owners at large. The association had altogether 1077 members, and every 31st member was chosen, resulting in 35 members and their contact information. The 15 interviewees were selected among this group based on variation criteria (Mason 2004). The forest holdings of these urban owners were spread throughout the country, and they represented different forest size classes and various landowner objectives. The holding size varied between 11 and 250 hectares. The age bracket of the interviewees was wide, from 40 to 83 years, but the level of education was rather high; most of them had at least a college degree. Gender representativeness was also considered in the sample. Therefore, six women and nine men were interviewed.

The data were collected with semi-structured interviews (Fielding and Thomas 2008). Forest owners were asked about their activities in the forest such as silviculture or cuttings. Ownership objectives were also examined. After that, climate change was discussed in order to map forest owners' views generally and in relation to their own forest (storm damage, drought, insects etc.). The storage of carbon with or without compensation, for instance, by refraining from timber harvesting completely, postponing thinnings or final harvests, or by enhancing forest growth by fertilizing the forest soil, were discussed prior to presenting hypothetical examples of voluntary policy programs on increasing carbon storage in private forests. This type of program, METSO, already exists to enhance biodiversity maintenance in private forests (see

Vanhanen et al. 2012). Finally, the forest owners' demographic information was collected with a separate one-page questionnaire.

The interviews were conducted in November/December of 2015, and they took, on average, 40 minutes. Saturation of the interviews was observed to take place during the 14th interview. The tape-recorded data were transcribed word for word, and themes and typologies were created based on the talk of the forest owners (see Mason 2004; Wengraf 2001; Galletta 2012).

The interview material was categorized by themes by selecting the sections of the interviews which were related to each theme. The given themes of the thematic interview outline were used as a starting point for thematization which aimed at highlighting interesting and important points as regards research objectives. The coding units were sentences and longer text parts in order to reflect the interviewee's point of view comprehensively. So, the observations in the analysis were parts of the language used by the interviewees. These quotations were utilized in the presentation of the results. The coding and classification of the material by themes was repeated several times in order to make sure that the codes were appropriate and organized under the correct themes. New themes did not emerge, but a total of eight themes were created as given in the outline of the interview. These themes were (1) the meaning and objectives of forest ownership, (2) the forest owners' perceptions of climate change, (3) the connection between climate change and their own forest, (4) the voluntary carbon storing in their forests, (5) limiting or postponing harvests, (6) increasing tree density, (7) fertilization and (8) decision-making factors. These were used in further analysis to create a forest owner typology based on forest owners' views on storing carbon in their forests.

The typologies were created by looking for regularities and deviances in the data. There are four different approaches in creating types: an authentic type based on one interview, a joint type based on the most of the interviews, a wide type (logical, potential but not probable) and a deviant type (Eskola and Suoranta 1998). The analysis in this study was based on identifying joint types (as common as possible) and deviant types.

Results

The forest owners' knowledge and beliefs about climate change

The interviewed forest owners expressed their concerns about climate change and its potentially disastrous effects on the globe. They believed that the average temperature would rise and cause the ice sheet to melt, and they also recognized effects such as rising sea levels, frequent heavy rains, increased storms, floods and dry seasons as well as more frequent heat waves. In Finland, this would mean, for instance, winters without snow. The forest owners believed that climate change would have impacts on the preconditions of normal life.

The interviewees also thought that climate change is a very complex issue and hard to understand completely. Some owners were confused about which phenomena were caused by climate change and which were not.

“Is this coincidence or climate change, what does climate change really mean, I am not sure ... Are the severe winters during my childhood just as much an illusion as the sunny summers? I have been pondering this.” (Female, 57 years)

The forest owners received their information on climate change mostly via the press, radio, television and the internet. They also felt that climate change would be

slow and take place over the long term, perhaps during the next 50 years. Therefore, some of the older interviewees did not worry about themselves.

“I am rather old, so long-term worries, they are the worries of the next generation.” (Male, 83 years)

The interviewees felt that it was not always clear that climate change would be a global phenomenon. Detrimental effects, such as the melting ice sheet or rising sea levels would cause problems for some islands in distant oceans.

Climate change and one's own forest property

The forest owners considered climate change to have both positive and negative effects on their forests. Storm damages and harmful insects were seen as threats. The interviewees were very worried about storms and were planning to buy or already had an insurance. The preservation of forests in their present form was felt endangered. Tree species and vegetation would change, conifers would suffer, and new species would invade. In addition, an accelerated increment of trees, thick snow covers, water imbalances and the shortening of the soil frost period were considered potential detrimental consequences of climate change. In contrast, positive features of climate change were detected. Forest growth would accelerate, the growing season would lengthen, and new tree species could be grown in their forests.

Forest owners did not see any connection between their forests and global warming. Accordingly, few had really taken any action in their forest to store carbon.

The quotation below describes a very exceptional forest owner.

“Maximizing timber volume is one way to sequester carbon, it is something I think about to some extent now that I am planning to do something.” (Male, 45 years)

Forest owners also often felt that their individual opportunities to affect climate change were limited. Climate change was regarded as such a powerful issue that an owner of a small forest parcel could not make any difference. The majority of owners should be mobilized.

“My role through my forest ownership is so small, what I do in my forest does not save the earth or [affect] climate change ..., the greater change should happen when forest owners’ willingness changes.” (Male, 40 years)

Storing carbon in one’s own forest

Most of the forest owners were familiar with the idea of carbon storage, and all of them were shown a diagram describing carbon circulation in the forest ecosystem. The forest owners had, in general, a positive attitude towards providing carbon storage services in their forests on the condition that they would be paid a fee by a company compensating for its emissions. However, a minority of the interviewees were not happy about this idea.

“This concept is fundamentally wrong, this is a license to pollute ... there should be cleaner and more noble goals, the compensation should come from more friendly and ethical sources.” (Male, 40 years)

Some forest owners had doubts about the amount of the monetary compensation. The compensation should be based on the value of the growing stock or the lost income from timber sales. However, for some owners compensation was not important, and they would be willing to test carbon storing in a small parcel even without it. A small forest area or the dominance of young stands would limit participation. The interviewees also wanted to know how forest management would be restricted or changed in order to enhance carbon sequestration. The decaying of old forests worried them as well.

“You should not postpone obligatory cutting when carbon sequestration has ended. I mean you should not let the forest decay, not even close.” (Male, 60 years)

“Carbon-friendly” forest management

The forest owners were rather well informed about the voluntary policy program on safeguarding biodiversity in private forests called METSO (Vanhanen et al. 2012). The program was used as an example of a potential policy program to enhance carbon storing in forests. For instance, refraining from final harvests completely or postponing them would also be appropriate means of storing carbon in forests. However, this might cause a problem if the forest owner wants a regular income from timber sales. In addition, the amount of compensation would be an important factor.

“If I am told not to cut when I want, I feel that is a problem ... they are timber production forests, so I don’t see a point in that, because they [forests] are so different.” (Male, 48 years)

Those forest owners emphasizing objectives other than wood production and timber sales income were more interested in participating in the carbon program and restricting their cutting accordingly. They were often willing to have a fixed-term contract or have only some parcels in the program at a time. Favorable attitudes towards nature conservation were connected with the willingness to participate in a carbon program.

Another means of increasing stored carbon in forests is to postpone thinning or refrain from it to increase biomass. Those owners who believed that a high density strategy to grow trees results in a good quality of timber and who relied on natural thinning were in favor of this treatment. They would also save money and effort in this way. These owners thought that they could just leave existing dense parcels without carrying out thinning. However, they still wanted to manage their forest to maintain its condition.

“Perhaps if you just clean out the deciduous rubbish, then you could refrain for a longer time ... you should somehow manage it anyway.” (Male, 65 years)

If wood production was important for the forest owner, the attitude towards leaving the forest without thinnings was negative. These owners felt that their forest would then produce less valuable logs. Some of the interviewees did not like the look of this kind of thicket, and others saw this kind of management to be in conflict with the best practice guidelines given by extension organizations. Compensation would be necessary for the owner to commit to this kind of forest management, although many thought that it would not be sufficient to cover the losses from not managing the forest normally.

Forest owners were very interested in mitigating climate change by enhancing forest growth by fertilizing the forest soil in some areas. This is not surprising because many owners had already used fertilization in their forests. However, monetary subsidies would be needed because fertilization was regarded as an expensive operation. In some locations, fertilization would not be appropriate, for instance, in very fertile soils or groundwater areas. A minority of owners were worried about the quality of the roundwood in fertilized stands.

Restrictions to committing to the carbon program

Forest owners emphasized the importance of monetary compensation when considering participation in carbon storage programs. The compensation should cover the income losses from refraining from timber sales. Other important factors concerning the willingness to participate were the length of the contract period and the possibility to cancel the agreement. If the owner was old, he did not want to make a long-term contract because it would restrict the use rights of the heirs.

“Thinking about how old I am, it [the contract] cannot be valid for many decades, I won’t need the forest any more or I have to hand it over to someone else, so you should not have any restrictions.” (Female, 63 years)

Fixed-term contracts were preferred as a less risky option. However, some owners were willing to discuss with their heirs about the involvement in this kind of carbon sequestration program. Participation in the program might also affect property rights and limit decision-making opportunities. The forest owners wanted to have the full title to their land due to bequest motives. The interviewees understood that some limitations to forest use were necessary, but they wanted to know these exactly and in advance. Forest owners should understand what their involvement entails.

Some forest owners were interested in the effectiveness of the program: how much carbon will be stored in the forest? The program should also be flexible in case of exceptional circumstances such as storm damage.

“If we think that there will be storm damage, say in several hectares of old forest, and if the contract says that you should not cut, there might be insect damage as well, if you cannot do anything for twenty years, the whole forest may be ruined. It does not make sense when thinking of carbon storing. ... Different flexible mechanisms would be needed.” (Male, 45 years)

Forest owner typology

Four types concerning forest owners' view on storing carbon in their forests could be identified: Pioneers, Potentials, Resistant and Indifferent Owners. The present typology differs from another Finnish typology identified by Laakkonen et al. (2018): Climate pragmatists, Climate purists, Climate deniers and Climate fatalists.

The Pioneer utilizes land versatilely and has already adopted practices to mitigate climate change. The Pioneer typically has a high level of education and multiple objectives for ownership that combine economic security, recreation and the enhancement of biodiversity. Instead of maximizing forest income, the Pioneer regards forest property as an asset or “bank”. The holding has been in the family for a longer

time, and the Pioneer knows the forest and also works there to counterbalance the daily office work.

The Pioneer is well aware of climate change and is able to identify its impacts based on general facts and research results. The Pioneer also believes that climate change has had an effect on own forest property. The Pioneer has adopted mitigating practices such as selecting certain tree species and maximizing biomass and views policy programs that enhance carbon storing in forests very positively. Compensations for changed forest management practices are welcome but not the only reason to take part in these programs. The guidance on how to manage the forest is the most important issue.

“It is a very fundamental phenomenon [climate change], and it changes the conditions of life. There are study results such as one article about small particles coming from coniferous trees which would cool down the climate, in a way reflect back solar radiation, and they said you should plant especially conifers. I had already ordered conifer plants and replanted them, and there were too many, and I got this idea, I thought why not, and planted the rest here and there.” (Male, 45 years)

The Pioneer has opinions on what kind of policy means would be effective and beneficial. An attractive program should be flexible and should not lead to remarkable income losses in forestry.

“I think that the kind of program that would be good is where the so-called older forest or mature forest is cut down and converted into wood products which serve as carbon storage. New stands would be grown to maximize the biomass, which in turn would store carbon, in a way functioning as a net flux.” (Male, 45 years)

The Potential emphasizes the recreational use of forests and also likes to work on the land and cut firewood for domestic use. The Potential often has a second home or summer cottage in the forest and might spend longer periods on the forest estate.

Economic security and the inherent value of forest ownership are important because the

property has been inherited. The Potential's attitude towards nature conservation is positive, although there may not be protected habitats on the property.

The Potential is concerned about climate change and its consequences, both in general and as regards own forest, and is aware of the mitigating effect of carbon stores in forests. However, this knowledge is not seen in forest practices. The Potential is worried about changing weather conditions such as the increased frequency of storms and has a positive attitude towards carbon storage in own forest. However, the Potential would like to combine current best practice guidelines with "carbon-friendly" management.

"Yes, at the moment I am affirmative. A good starting point would be that there would be many kinds of trees in the woods, as it says in best practice guidelines that there should be mature stands and juvenile stands, so these instructions and plans should be close to each other [best practice guidelines and 'carbon-friendly' management], but I am ready to postpone cutting, I have done that before." (Male, 68 years)

The Potential points out that participation in storing carbon in own forest should not restrict recreational use and the procurement of firewood. The Potential also wants to somehow manage forests to maintain their well-being but might participate in the program as a trial with a small parcel. The Potential is interested in the preconditions of participation and management options. However, the amount of compensation would not be the main criterion for involvement.

"If you could manage it [the forest] further somehow, so that it will not be completely ruined, this comes to my mind first, and of course if you give up something, that is the way to go, to have a compensation system, so a little bit of money as well." (Male, 65 years)

The Resistant is typically an owner of a larger forest estate and has economic objectives to maximize wood production or timber sales income. Forest ownership means additional income, and the Resistant wants to ensure a continuous cash flow from forestry. The Resistant does not emphasize recreational use and is not interested in nature conservation and uses service providers in timber sales and forest management.

“It [the forest property] is so far away and there is no summer house... yeah, it is just my business.” (Male, 80 years)

“It is mostly like an additional income, to be straight ... these areas are commercial forests, and they’ve always been so, so it would take a while before they would have value for nature conservation, so I am somehow a loser in this sense.” (Male, 48 years)

The Resistant is generally aware that the climate is changing but does not recognize its consequences for own forest ownership. There is a fundamental contradiction between carbon storing and timber production. If the Resistant considered participating in a carbon program, the monetary compensation would be the main criterion. The only acceptable management option to increase carbon in the forest would be fertilization because it also increases the growth of trees and thus intensifies timber production.

“Well, the climate change, at least if these ways to produce energy, they are very important, and traffic, you should develop these alternative sources of energy and also save [energy] ... so I think that the other sectors in society are in a key position.” (Male, 53 years)

The Indifferent Owner has no definite objectives for forest ownership. This may have led to unmanaged forests and the avoidance of cutting for a longer period. The Indifferent Owner visits the forest property very infrequently, so the forest is not used for recreation. The knowledge about own forest and its potential is weak. The forest property has no inherent value, and there are no emotional ties. One option for the Indifferent owner is to sell the forest area in the future.

“I cannot travel there, there has been no cutting for decades. It has just been left there to wait ... I haven’t any strategy for it, I have been so busy, so I haven’t been able to...” (Female, 68 years)

The Indifferent Owner also believes that climate change is taking place and might have worries about that, and is even able to identify a few consequences of this change but without having a global perspective. The Indifferent Owner mentions the melting of the ice sheet and the sinking of some islands into the ocean but has no opinion on the connection between climate change and own forest. The Indifferent

Owner is rather reluctant to store carbon in own forest. The main aspect to participate in the carbon program would be compensation, although there has not been any income from the forests for years. The Indifferent Owner has no idea of the requirements of “carbon-friendly” forest management or management options in practice.

“So that you should leave the trees to absorb carbon in the roots, and what would happen when they rot and collapse? How much would the compensation be, so that is it close to the value of the growing stock ... yeah, I think that you should get proper compensation, so that it would match timber sales or a similar profit, so compared to the trouble although you need not do anything, but you lose income anyway.” (Female, 68 years)

The forest owner typology is summarized in Table 2.

(Table 2 around here)

Discussion

The qualitative approach applied in this study does not and cannot aim at statistical representativeness of the results. However, the use of a small purposeful sample and in-depth interviews potentially gives deeper insights on forest owners’ views on climate change and carbon storing in their forests. Hypotheses based on these notions can potentially be verified with statistically representative data in the future.

According to the study results forests as carbon fluxes appear to be a familiar concept to most of the forest owners, but carbon storage in their own forests was a new and unfamiliar idea. Although climate change was commonly acknowledged, most forest owners did not realize the potential of carbon storage in their own forests as a means to mitigate climate change. However, they were often interested in the issue and in general had positive attitudes towards storing carbon in their forests. Previous studies have suggested that positive attitudes and knowledge of the mitigating effect of forests will positively affect the intention to participate in carbon storage (Markowski-Lindsay

et al. 2011; Miller et al. 2012; Thompson and Hansen 2013). This compares well with the results concerning the Pioneers in this study, who were well aware of these issues. The Potentials, instead, need more experience and more knowledge about the means of increasing carbon sequestration in their forests. According to Thompson and Hansen (2013), forest owners' ability to manage forests to enhance carbon storage and a realistic idea of the needed resources increase intentions to participate in carbon storage.

When forest owners underestimate their own potential to influence or believe that climate change will happen in the distant future, they are not likely to store carbon in their forests. Vainio and Paloniemi (2011) claim that the knowledge of climate change does not lead to climate-friendly activity if the person does not realize his opportunities to engage in mitigating actions. In this study, the Resistants and Indifferent Owners did not see the connection between climate change and their forest ownership, although they did believe in climate change. This diminished their motivation to participate in carbon programs.

According to Urquhart et al. (2012), the delivery of public goods from private forests is limited by its contradiction to other objectives that forest owners have for their forests. This compares well with the current study, especially concerning the Resistants, who felt that carbon storage would jeopardize timber production and timber sales incomes. Their plans to carry out cutting had a negative effect on participating in carbon storage, which contradicts with the results by Markowski-Lindsay et al. (2011). In the light of the previous literature (Markowski-Lindsay et al. 2011; Miller et al. 2012; Thompson and Hansen 2013; Tian et al. 2015; Khanal et al. 2017), having non-timber objectives for forest ownership would increase forest owners' interest in carbon storage. This notion is well in line with the current study results concerning the Pioneers and Potentials.

Due to the qualitative approach applied in the study, it is difficult to make conclusions about the relationships between demographic factors and the willingness to store carbon in forests. However, in this study, a high level of education seems to be connected to interest in carbon storage, as noted by Markowski-Lindsay et al. (2011), Dickinson et al. (2012) and Rämö et al. (2013), see also Laakkonen et al. (2016).

According to the forest owners, a small forest area or the dominance of young stands would limit participation in carbon storing programs. This underestimation of one's own opportunities was also noted by Koskela (2011) in relation to voluntary biodiversity conservation on private lands. On the other hand, a large forest acreage does not necessarily lead to positive views on participation, as shown by the Resistant type (cf. Khanal et al. 2017). Thompson and Hansen (2012) concluded that this may be because owners of large estates are more habitual in their forest management and less open to new approaches.

From the point of view of forest owners, the most important characteristic of policy programs enhancing carbon storage in private forests was cost-sharing, that is, monetary compensation. This has often been identified as an important factor in the previous literature (e.g. Horne 2006; Fletcher et al. 2009; Markowski-Lindsay et al. 2011; Miller et al. 2012; Dickinson et al. 2012; Håbesland et al. 2016; Latta et al. 2016; Khanal et al. 2017). However, the forest owners had doubts about whether the compensation fully covers the costs of participation or the lost income from timber sales. On the other hand, exceptions such as the Pioneers already practice carbon-friendly forest management without any compensation.

Other features that affected the forest owners' participation were the duration of the contract, the ability to cancel and restrictions on property rights. According to the study results, the forest owners were more willing to participate if the contract term was

fixed and short term and when a full title to the land prevailed and canceling was an option if the owner changes (Koskela 2011; Wade and Moseley 2011; Markowski-Lindsay et al. 2011; Dickinson et al. 2012; Urquhart et al. 2012).

The forest owners were also interested in how participation in carbon storing would limit the utilization of forests. They emphasized the compatibility of best practice guidelines and forest management plans with carbon-friendly management. In addition, some flexibility would be needed so that forest owners could manage their forest to keep it easily accessible and to prevent the trees from decaying.

Carbon storage can be increased in forests by various changes in harvesting and forest management. According to the forest owners, the most acceptable means was fertilization. This is partly because they have past experience of fertilization. Even the Resistant would accept forest fertilization because it enhances timber production. However, fertilization is not the most likely management option in cost-share programs for environmental reasons such as nutrient leakage to water bodies.

Forest owners appear to have positive attitudes towards storing carbon in their forests, in general. Economic factors are important for many owners when they consider their participation in potential carbon sequestration programs. The amount of financial compensation must be carefully analyzed when planning policy programs. For many owners, a pecuniary compensation is the primary motivation to participate in storing carbon. Forest owners do not necessarily recognize the connection between forms of forest management and their potential effect on climate change. The absence of value-driven willingness to mitigate climate change makes this instrument vulnerable to changes in the amount of compensation or other mechanisms.

Informational guidance on the role of forests in mitigating climate change and tailored forest management for reducing carbon emissions along with an agreement with

flexible terms should be other key elements in the voluntary cost-share programs.

Finally, it is important to note that these programs need not to be attractive for all forest owners: perhaps it will do if the Pioneers and Potentials will be involved. Compensation is not the most important aspect. For the Pioneers further information is the key element in assessing various management options. The Potentials need clear instructions how to manage their forests taking into account also recreational use of their forests.

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Table 1. Factors influencing family forest owners' willingness to participate in carbon storage programs (a. Horne 2006; b. Rämö et al. 2013; c. Fletcher et. al. 2009; d. Dickinson et al. 2012; e. Wade and Moseley 2011; f. Markowski-Lindsay et al. 2011; g. Thompson and Hansen 2013; h. Miller et al. 2012; i. Tian et al. 2015; j. Khanal et al. 2017).

General economic factors	
Low market price of carbon in the carbon trade (c)	(-)
Underdevelopment of the carbon trade (e)	(-)
Low profitability of the carbon trade (e)	(-)
Profitability of wood production (NPV) (j)	(+)
Policy instruments and contracts	
Subsidy on carbon sequestration (a, b, c, d, f, h, i, j)	(+)
Long duration of contract (a, d, f, h)	(-)
Preservation of property rights (b, e)	(+)
Owner's own initiative (a)	(+)
Difficult to follow instructions (e)	(-)
Tight limitations for use (a)	(-)
Penalty for premature cancellation (a,c, d, f)	(-)
Potential additional obligations (e.g. certification) (f, h)	(-)
Hesitation of experts to recommend participation (e)	(-)
Management requirements (e.g. management plan, verification) (d, f, j)	(-)
Owner and holding characteristics	
Old age (f, i, j)	(+/-)
Gender male (d, h, i)	(+/-)
High professional status (b, i)	(+/-)
High level of education (b, d, f)	(+)
High household income (j)	(+)
High non-timber income (e.g. hunting licenses) (h)	(+)
Long length of tenure of the holding (i)	(+)
Large forest acreage (j)	(+)
Absentee ownership (h)	(+)
Capacity to manage forest accordingly (g)	(+)
Knowledge of the necessary resources in carbon sequestration (g)	(+)
Positive attitude towards carbon sequestration (h, g)	(+)
Knowledge of the role of forests in climate change mitigation (f)	(+)
Innovativeness (g)	(+)
Moral objections (e)	(-)
Plans to harvest (f)	(+)
Ownership objectives	
Non-timber objectives (f, h)	(+)
Bequest motive (i)	(-)
Intention to sell forest estate (i)	(-)
Tranquility and stillness (i)	(+)
Nature orientation (g)	(+)
Recreation (j)	(+)
Timber production (f)	(-)

NB! Horne (2006) examines the voluntary safeguarding of biodiversity in private forests. However, this topic potentially gives hints about forest owners' views on carbon storage.

Table 2. Forest owners' views on storing carbon: owner typology.

	Pioneer	Potential	Resistant	Indifferent Owner
Owner and holding characteristics	High level of education		Extensive forest acreage	
Forest ownership: meaning and objectives	The forest functions as a "bank" but also has a recreational function Multiple objectives Inherent value of forest ownership	The forest is important for recreation but also because of economic security for the future Recreation and leisure Inherent value of forest ownership	The forest provides additional income and is an object of investment Timber production and timber sales income	The forest just "exists" and the level of knowledge of his forest and its potential is almost non-existent No specified objectives
Nature conservation	Combines nature conservation with other objectives	A positive attitude towards nature conservation	Takes no voluntary actions for maintaining nature conservation	No opinion about nature conservation
Views on climate change	Knowledge is based on facts e.g. study results	Concerned about climate change and associates it with changed weather conditions	Views on climate change are based on media and believes that climate change is taking place	Believes that climate change is a fact and is worried about it to some extent, but does not see it as a global phenomenon
Climate change and own forest	Sees that climate change affects forest ownership, and takes carbon sequestration into account in forest management	Aware of the role of forests in mitigating climate change, but this is not connected to own forest practices	Does not believe that climate change affects own forest ownership	Does not see any connection between climate change and own forest ownership
Attitude towards potential programs on carbon storing	A very positive attitude towards carbon programs and able to critically assess the pros and cons of different alternative means	Wants to follow how the program functions and is interested in the preconditions of participating. Also interested in various means and wants to combine carbon sequestration with the Best Practice Guidelines for Sustainable Forest Management	A negative attitude due to conflict with other objectives of forest ownership. Fertilization would be an acceptable means to increase carbon storage in own forest	No distinct opinion on participating in a program and does not really understand its preconditions. Unable to assess the optimal alternative for increasing carbon storage in own forest
Compensation	An additional benefit for participating in the programs, but guidance alone motivates to action	Important to some extent, but the most important aspect the possibility for recreational use	The most important criterion if considering participating	The most important criterion, although the forest has not created income in years